Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

34 C

LIBRARY
RECEIVED
★ 1934 ★
U.S. Department of Agriculture

CIRCULAR No. 325 SEPTEMBER 1934
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

FIELD EXPERIMENTS WITH VERNALIZED WHEAT[1]

By H. H. McKinney, *senior pathologist;* W. J. Sando and Arthur F. Swanson, *associate agronomists;* Vincent C. Hubbard, Glenn S. Smith, Coit A. Suneson, and Joe L. Sutherland, *junior agronomists, Division of Cereal Crops and Diseases, Bureau of Plant Industry*

CONTENTS

	Page		Page
Introduction	1	Results of experiments	3
Methods of vernalization	1	Conclusions	6

INTRODUCTION

The experiments reported in this circular were conducted during 1933, in order to obtain information on any possible commercial usefulness that might be derived from the vernalization of certain standard varieties of winter and spring wheats before seeding in the spring.

As previously reported,[2] it was known in the United States many years ago that winter wheats will head and produce a crop when sown in the spring if the seeds are first germinated slightly and chilled near freezing for a sufficient time before sowing. However, the method was never used extensively, and it appears that most investigators were unaware until recently that the method had ever been advocated in the United States.

In 1933 Russian workers recommended the commercial use of the method on the grounds that vernalized winter wheats outyield spring wheats and that the durum wheats make better yields when vernalized.

METHODS OF VERNALIZATION

Because of varied facilities it was impracticable to conduct uniform tests with all varieties at all stations.

The varieties used were Turkey, Kanred, Red Rock, Minhardi, Early Blackhull, Quivira, and Blackhull winter wheats and Marquis, Ceres, Mindum, and Kubanka spring wheats, the two latter varieties being durums.

Seedings were made at the Arlington Experiment Farm, Rosslyn, Va.; at the Fort Hays Branch Station, Hays, Kans.; in Nebraska at the State College of Agriculture, Lincoln, and at Alliance; at the Judith Basin Branch Station, Moccasin, Mont.; and in North Dakota at the United States Northern Great Plains Field Station, Mandan, and at the Langdon Substation, Langdon. The last-named station is about 20 miles from the Canadian border.

---

[1] Vernalization is the anglicized form of the Russian term "iarovization" suggested in the following publication: Whyte, R. O., and Hudson, P. S., vernalization or lysenko's method for the pretreatment of seed. Imp. Bur. Plant Genetics Bull. 9, 27 pp. 1933.

[2] McKinney, H. H., and Sando, W. J., earliness and seasonal growth habit in wheat. Jour. Heredity 24: 169–179. 1933.

Plantings were confined to rod rows at all stations except at Arlington farm, where both rod and 5-foot rows were grown.

The slightly germinated seeds were chilled by several methods. At each station except the Arlington Experiment Farm seed of winter wheat was chilled during the winter in buildings or under straw out of doors. In some cases seed also was chilled in cold-storage rooms or in a mechanical refrigerator at temperatures ranging near freezing.

The methods used in Russia for the vernalization of large quantities of wheat seed were summarized in a previous publication[3] and this summary is again presented as follows:

> *Winter wheats*: The grain is spread in a layer from 6 to 7 inches deep on a floor. Water at the rate of about one-third of the weight of the seed is sprinkled over the seed, the water being applied in thirds with intervals of 8 hours between the applications. The final moisture content of the seed should be 50 to 55 percent. The seed is allowed to germinate at 50° to 60° F. for about 24 hours and is shoveled over three or four times during the process. The germinated seed is held at 32° to 34.2° F. for 40 to 55 days and is stirred many times during the process of chilling.
>
> *Spring wheats* (durums): The moisture content is raised only to 45 to 50 percent. The germinated seed is held at 33.8° to 41° F. for 10 to 15 days.

Tests carried out at the Arlington farm indicate that seed can be soaked in an excess of water for 6 to 8 hours, depending on the size and hardness. After soaking, the excess water is poured off and the seed is germinated very slightly near 70° F. If the seed contains more than 50 to 55 percent of water based on the dry weight of the seed after germination, it should be dried to this water content. The seed is then held at temperatures slightly above freezing for suitable periods. Small amounts of seeds are held in jars, bottles, or waxed cardboard containers, which are closed except for a small vent. The seed must be stirred frequently, and the moisture may require adjustment during the treatment.

At the Arlington farm all seed was chilled in a cold-storage room at or slightly above the freezing point. The seed was chilled in shallow boxes or in mason jars and then dried.[4] A portion was sent to the several stations and a portion used at Arlington farm. Seed prepared at the stations other than Arlington farm was sown at those stations without being dried.

---

[3] McKinney, H. H., and Sando, W. J. RUSSIAN METHODS FOR ACCELERATING SEXUAL REPRODUCTION IN WHEAT. Jour. Heredity 24: 165–166. 1933.

[4] At the end of the chilling treatment seeds may be dried, providing the sprouts are short (one-sixteenth of an inch or less). However, it is best to sow the seed while it is still slightly moist. Dried seed should be sown as soon as possible. Viability of germinated seed which has been dried becomes reduced more rapidly at high than at low storage temperatures. Seed of Turkey which was pregerminated and dried (plumules one thirty-second of an inch long) was stored at 38° F. and at 76° and 84° for 12 days. Germination tests were made with 200 seeds of each sample in soil. In the ungerminated control 98 percent germination was obtained. The pregerminated seed held at 38° gave 87.5 percent germination, and the sample held at 76° to 84° gave 72.5 percent germination. Dried pregerminated seed of Marquis and Turkey which had been chilled before drying was stored at 70° to 85° for 3 months at Rosslyn. At the end of this time no germination occurred in moist chambers or in soil at summer temperatures. When such seed of Turkey was stored under ordinary seed-house conditions for 5 months at Lincoln, Nebr., only 6 plants became established from 2,400 seeds sown.

RESULTS OF EXPERIMENTS

Seed which was chilled in sheds or under straw out of doors gave very poor results at all the stations where these methods were used. The temperatures either went too high and induced molding and overgermination or they went too low and caused killing. For this reason this circular includes data only for the seedings made with seed chilled in cold-storage rooms or mechanical refrigerators.

Winter wheat from unchilled seed headed only at Moccasin and Langdon, and at these stations heading was delayed and irregular.

In table 1 comparisons are made between the chilled winter wheats grown at Langdon and at Rosslyn. The data were not given statistical treatment, as there seemed little to be gained thereby. The earliest heading with one exception was in plants from seed chilled for 65 days. Next in order was the series chilled for 50 days, followed by that chilled for 35 days. Thirty-five days of chilling was inadequate at both stations. However, this treatment and the 50-day treatment induced heading in a greater percentage of plants at Langdon than at Rosslyn. Other work indicates that had sowings been made in March instead of April 15 at Rosslyn a higher percentage of the plants would have headed.

TABLE 1.—*Results from vernalized wheat seed sown at Rosslyn, Va., Apr. 25, 1933; at Langdon, N.Dak., May 1, 1933; and at Mandan, N.Dak., Apr. 24, 1933*

[The germinated seed was chilled near 33° F. in a cold-storage room at Arlington farm, Rosslyn, Va. After chilling it was dried near 75°-85° and portions were sent to Langdon and Mandan, and a portion was used at Rosslyn. At Rosslyn sowings were made in three 5-foot rows replicated three times. At the other stations the rod-row method was used. Data are based on the average of the three center rows]

Variety	Treatment	Estimated stand			Date of first heading			Plants headed			Yield per acre		
		Rosslyn	Langdon	Mandan	Rosslyn	Langdon	Mandan	Rosslyn	Langdon	Mandan	Rosslyn	Langdon	Mandan
		Percent	*Percent*	*Percent*				*Percent*	*Percent*	*Percent*	*Bushels*	*Bushels*	*Bushels*
Marquis	Unchilled, ungerminated	80	85		June 20	June 28		100	100		4.3	17.2	
Turkey	Chilled 65 days	68	85		June 26	June 29		75–100	100		2.0	16.1	
Do	Chilled 50 days	75	85		July 5	July 2		10–50	100		0	15.3	
Do	Chilled 35 days	82	85			July 5		0–1	100		0	9.7	
Do	Chilled 0 days	85	90					0	[1] T		0	0	
Kanred	Chilled 65 days	65	85		June 26	July 1		85–100	100		2.7	16.1	
Do	Chilled 50 days	70	85		July 2	July 2		50–75	100		5.2	19.3	
Do	Chilled 35 days	70	85		Aug. 1[2]	July 5		0–1	100		0	12.5	
Do	Chilled 0 days	75	90					0	T		0	0	
Marquis	Unchilled, ungerminated	85	85		June 19	June 29		100	100		5.4	18.9	
Minturki	Chilled 65 days	58	85		June 29	July 2		75–95	95		1.7	13.0	
Do	Chilled 50 days	75	85		June 30	July 4		10–50	85		0	15.9	
Do	Chilled 35 days	75	85			July 6		0–1	60		0	11.0	
Do	Chilled 0 days	75	90					0	T			0	
Minhardi	Chilled 65 days	48	60		July 18[3]	July 5		0–1	75		0	6.1	
Do	Chilled 50 days	55	50		July 12[2]	do		0–1	65		0	7.2	
Do	Chilled 35 days	60	30			July 8		0–1	30		0	1.3	
Do	Chilled 0 days	65	90					0	T		0	0	
Marquis	Unchilled, ungerminated	78	85	98	June 19	June 30	June 27	100	100	100	4.5	14.3	10.4
Do	Unchilled, germinated	75	85	97	June 18	June 29	June 26	100	100	100	4.9	16.3	11.1
Do	Chilled 35 days	76	85		do	do		100	100		5.7	16.7	
Do	Chilled 21 days	70	85		June 19	June 30		100	100		5.5	15.9	
Do	Chilled 16 days	78	85	98	June 18	June 29	June 27	100	100	100	5.1	18.4	10.5
Do	Chilled 10 days		85	98		June 28	do		100	100		19.1	11.9
Do	Unchilled, ungerminated	82	85	98	June 18	June 30	June 26	100	100	100	6.6	17.8	10.1
Mindum	do	70	85	96	June 23	July 1	June 27	100	100	100	2.3	19.4	13.1
Do	Unchilled, germinated	65	85	96	June 22	do	June 28	100	100	100	2.5	19.3	12.4
Do	Chilled 16 days	66	85	95	do	June 29	June 26	100	100	100	2.0	23.5	12.1
Do	Chilled 10 days		85	95		June 30	June 28		100	100		20.1	12.5
Marquis	Unchilled, ungerminated	80	85	97	June 19	do	June 26	100	100	100	4.6	18.1	11.9
Kubanka	do	70	85	95	June 21	June 29	June 28	100	100	100	3.9	16.1	12.0
Do	Unchilled, germinated	66	85	96	June 23	June 28	June 27	100	100	100	2.0	17.7	13.7
Do	Chilled 16 days	73	85	97	do	do	do	100	100	100	3.5	18.7	13.0
Do	Chilled 10 days		85	96		June 29	do		100	100		21.5	11.5
Marquis	Unchilled, ungerminated	77	85	98	June 19	do	June 26	100	100	100	4.4	14.9	15.3
Ceres	do	76	85	95	do	June 28	do	100	100	100	4.3	14.5	13.3
Do	Unchilled, germinated	72	85	97	June 18	June 26	June 25	100	100	100	3.9	16.8	11.9
Do	Chilled 16 days	78	85	98	June 19	do	June 24	100	100	100	4.3	14.5	11.4
Do	Chilled 10 days		85	98		do	June 25		100	100		18.1	10.8
Marquis	Unchilled, ungerminated	83	85	98	June 19	June 29	June 27	100	100	100	4.4	17.0	9.4

[1] T=trace.

[2] Few heads in but 1 row.

[3] Few heads in but 2 rows.

At both stations Minhardi reacted inefficiently to the chilling treatment, which is consistent with tests reported previously.[5] At Rosslyn, Kanred headed more efficiently than the other varieties.

At Langdon, fairly good yields were obtained with Turkey, Kanred, and Minturki from seed chilled 50 and 65 days. Kanred seed chilled 50 days outyielded all of the Marquis controls, though in some cases this difference was very slight and is not statistically significant. The Mindum control (unchilled) produced one tenth of a bushel more than Kanred. Previous experience shows that seeds can be overchilled to a point where yield may be reduced under certain conditions of subsequent culture.

At Mandan, Turkey sown April 24 gave a yield of 7.9 bushels per acre from seed chilled near 33° F. for 67 days at Rosslyn. The Marquis unchilled controls gave yields ranging from 9.4 to 15.3 bushels per acre. Unchilled Turkey did not head.

At Moccasin, Turkey wheat grown from moist seed chilled at 33° F. in a creamery for nearly 4 months and sown April 1 gave a yield of 13.9 bushels per acre. Unchilled Turkey headed late and gave a yield of 7.7 bushels per acre. Unchilled Marquis gave a yield of 14 bushels per acre.

At Alliance, Turkey wheat sown April 11 gave a yield of 2.4 bushels from seed held at approximately 33° F. for 67 days at Rosslyn. Unchilled Marquis gave a yield of 5.5 bushels per acre.

At Rosslyn, Turkey wheat sown March 29 gave a yield of 4.2 bushels per acre from seed chilled at approximately 33° F. for 67 days. Unchilled Marquis gave a yield of 12.7 bushels per acre.

At Hays, Early Blackhull, Quivira, Kanred, and Oro winter wheats sown March 18 gave yields of 15.2, 13.6, 7.1, and 9.8 bushels per acre, respectively, from seed chilled at 32° F. and below in a local cold-storage room for 97 days. These same varieties yielded 12.4, 10.0, 6.8, and 11.6 bushels per acre, respectively, from seed chilled locally at 28° to 32° in a mechanical refrigerator for 97 days. Red Rock and Turkey winter wheats sown March 25 headed sparingly and gave no yield from seed chilled for 51 days at Rosslyn. Unchilled Marquis seeded at the same time yielded 4.2 bushels per acre. Unchilled Turkey failed to head.

Results from chilled winter wheats were more satisfactory at Langdon and Moccasin than at the other stations. Data previously persented by McKinney and Sando [5] suggest such results. The degree of difference normally to be expected is not shown by present data because of drought prevailing in 1933. The longer days and lower temperatures of the North should be more favorable for heading and yield from vernalized seed than the shorter days and higher temperatures of more southerly points.

The results from chilled spring varieties are presented in table 1. Earliness was modified so slightly by chilling that the effect was of no practical consequence.

At Langdon, higher yields were obtained from chilled seed of Marquis, Mindum, Kubanka, and Ceres spring wheats. At Mandan the unchilled seed gave the highest yields in all spring varieties but Marquis, which gave a slight increase from chilled seed.

---

[5] McKinney, H. H., and Sando, W. J. See footnote 2.

The yield data of the chilled spring wheats grown in 5-foot rows at Rosslyn were irregular and are not considered significant.

CONCLUSIONS

From the technical standpoint further experiments are necessary to determine the commercial value of vernalization in the United States. However, the information now available seems to indicate that the method does not offer great possibilities in commercial wheat production. There are available so many standard spring varieties well adapted to the spring-wheat regions in this country that there appears to be no need for vernalizing winter varieties, and it seems doubtful if yields of vernalized spring wheat will be increased to a point which will attract farmers even in the northern areas.

Vernalization might be useful in certain limited winter-wheat areas if the present procedure could be made somewhat more practicable. Most winter wheats tolerate low temperatures during the initial growing period better than most spring wheats, and vernalized winter wheats might be used to advantage for late winter and very early spring sowing where the autumn sowing has been prevented by excessive rainfall or drought. In such cases early varieties of winter wheat which have been vernalized might have advantages over spring varieties.

All tests conducted thus far indicate that very late winter varieties have no place in such a program except possibly in regions having a long favorable growing season. As in the case of spring wheats, winter wheats differ in their relative earliness and lateness, and this relationship between varieties of winter wheat is not modified apparently by complete vernalization.

The resowing of winter-killed wheat with vernalized seed is of questionable value in this country, since in too many cases the need for resowing cannot be determined in sufficient time to permit vernalizing.

Temperatures for chilling can range above and below freezing during the treatment, but those slightly above are best. If temperatures go too high, molds will develop. Germination must be held to a point enabling the use of a grain drill for seeding. Germination can be retarded by controlling the moisture content of the seed and by preventing too high temperatures. If the germinated seed becomes too dry during the chilling process the desired physiological changes will be retarded or stopped completely. More than average skill is required to prevent excessive molding and sprouting. In the winter-wheat areas of the United States the winter temperatures frequently are too high for successful results when the treatment is carried out in barns, sheds, or granaries. If the work is done in a cold-storage room the cost of the treatment will increase considerably. In the spring-wheat areas the proper temperatures can be maintained more consistently than in the winter-wheat areas. However, protection is necessary against extremely low temperatures.

For the rapid increase of progenies and selections in winter wheat, chilling methods can be used to advantage. Relatively small plots are used in this type of work, and it is practicable to seed by hand. Hand seeding permits the use of seeds with longer plumules and roots than does machine seeding. Good stands have been obtained when moist seedlings with plumules three eighths of an inch long and roots 1 inch long were planted with the plumules purposely inverted into the soil in the seed trench. In hand seeding such seedlings it is not necessary therefore to orient the plumule. Soil moisture must be available to keep such seedlings growing. For experimental propagation the moist germinated seeds may be chilled in mass in bottles or jars or they may be quickly sown in soil in small open containers or in pots or flats. The rate of growth of the roots and plumules is retarded by reducing the moisture content of the seed or soil to a point which will maintain very slow growth.

The spring varieties tested thus far have not been injured when the slightly germinated seed is chilled near 34° F. for periods as long as 65 days. It appears, therefore, that little if any injury is likely to result from vernalizing segregating populations from crosses between winter and spring types.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Under Secretary	REXFORD G. TUGWELL.
Assistant Secretary	M. L. WILSON.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Director of Finance	W. A. JUMP.
Solicitor	SETH THOMAS.
Agricultural Adjustment Administration	CHESTER C. DAVIS, *Administrator.*
Bureau of Agricultural Economics	NILS A. OLSEN, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	J. N. DARLING, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	KNOWLES A. RYERSON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Weather Bureau	WILLIS R. GREGG, *Chief.*

This circular is a contribution from

Bureau of Plant Industry	KNOWLES A. RYERSON, *Chief.*
Division of Cereal Crops and Diseases	M. A. MCCALL, *Principal Agronomist, in Charge.*

U. S. GOVERNMENT PRINTING OFFICE: 1934

For sale by the Superintendent of Documents, Washington, D.C. - - - - - - Price 5 cents

. (cd.2)
934
264972